Data structures

Videogames Technology
Escuela Politécnica Superior

Departamento de Automática

Objectives

1. Understand the need to store information in data structures.
2. Identify most appropriate data structure according to the problem.
3. Understand the role of lists in Arcade.
4. Basic usage of sprites in Arcade.

Table of Contents

Data structures

Introduction

Programming is about information representation.

- Simple data are easy to represent: Numbers, characters, strings, etc.

Reality uses to be more complicated.

- A class represent an object.
- How can we store several objects?
- How can we represent complex data?

We need powerful mechanisms to store information: Data structures.

Data structures

Array

Vector (1-D array)

0	1	2	3
a_0	a_1	a_2	a_3

Matrix (2-D array)

	0	1	2	3
0	$a_{0,0}$	$a_{0,1}$	$a_{0,2}$	$a_{0,3}$
1	$a_{1,0}$	$a_{1,1}$	$a_{1,2}$	$a_{1,3}$
2	$a_{2,0}$	$a_{2,1}$	$a_{2,2}$	$a_{2,3}$

Advantajes:

- Very fast

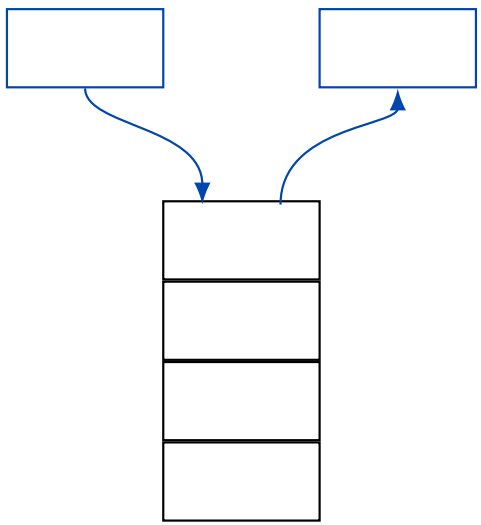
Disadvantajes:

- Fixed size
- Not supported in Python by *default*
  - `NumPy`

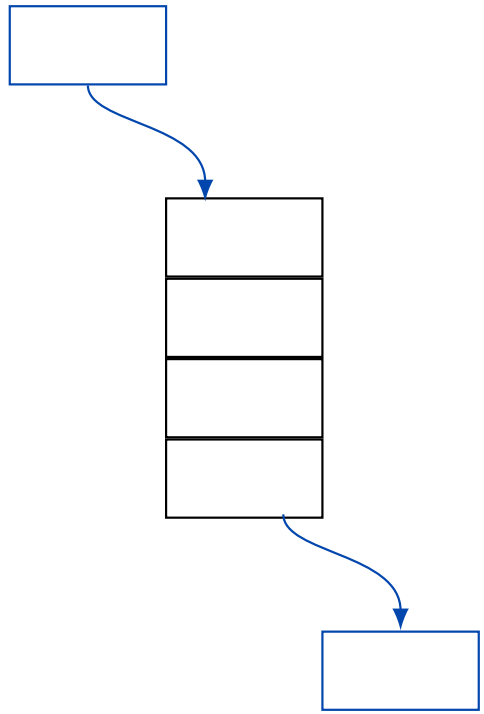
Data structures

Data structures (I): Stack and queue

Stack (LIFO)



Queue (FIFO)



Operations:

- `push(value)` and `pop(value)`

Implemented as lists in Python

Data structures

Lists and hash tables

Lists

Operations:

- `insert(pos, value)`
- `get(pos)`

Hash table (associative array, dictionary)

Key 1	Value 1
Key 2	Value 2
Key 3	Value 3
Key 4	Value 4

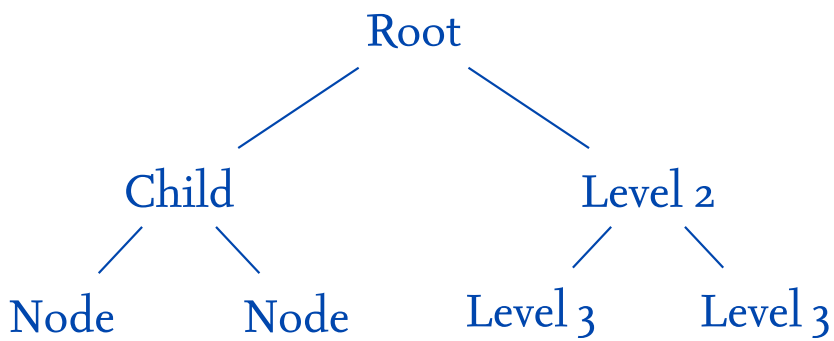
Operations:

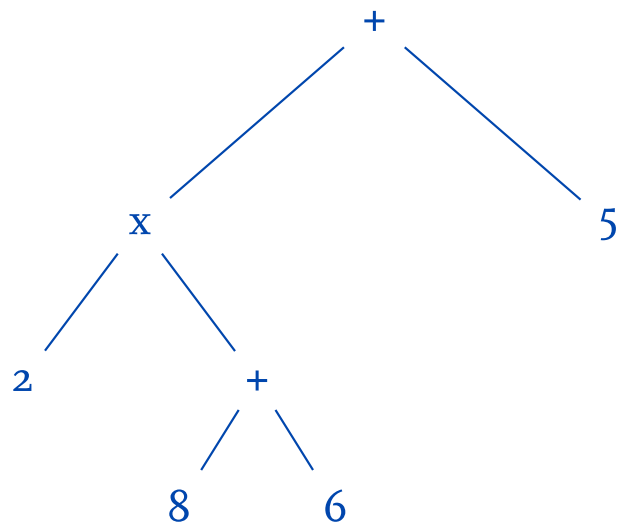
- `put(key, value)`
- `get(key)`

Data structures

Trees (I)

Trees





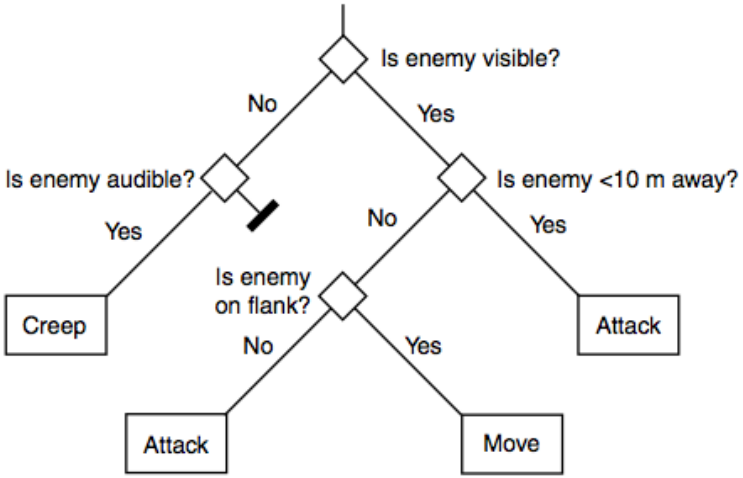
Operations:

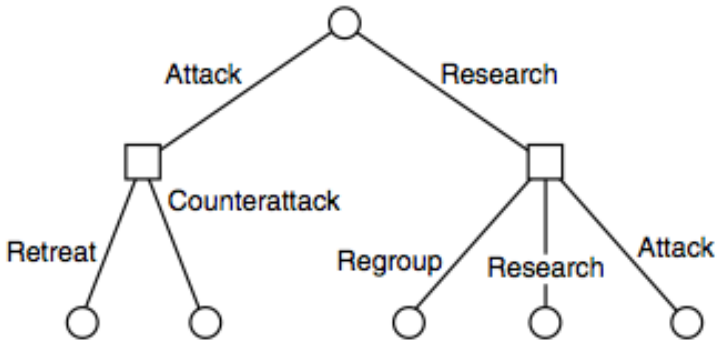
- `insert()` and `remove()`
- `search()`

$2 * (8 + 6) + 5$

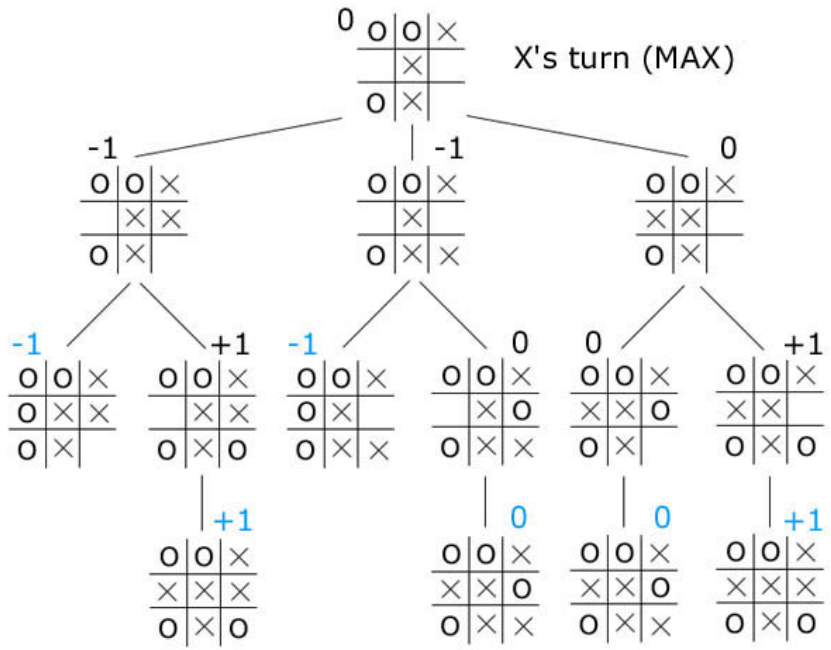
Data structures

Trees (II)





Source: Ian Millington, John Funge. "Artificial Intelligence for Games". Ed. Morgan-Kaufmann. 2009.

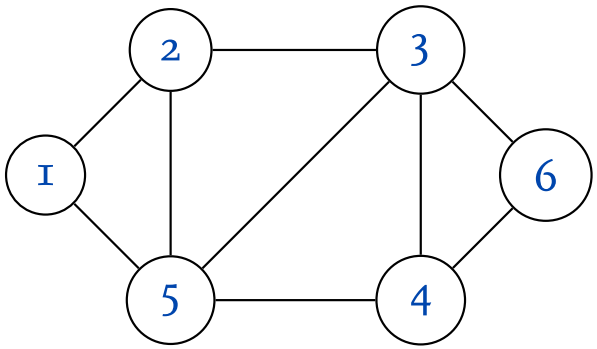


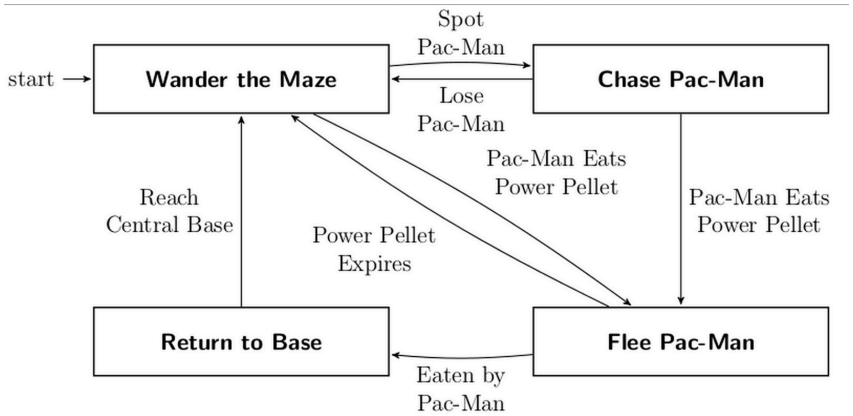
(Source)

Data structures

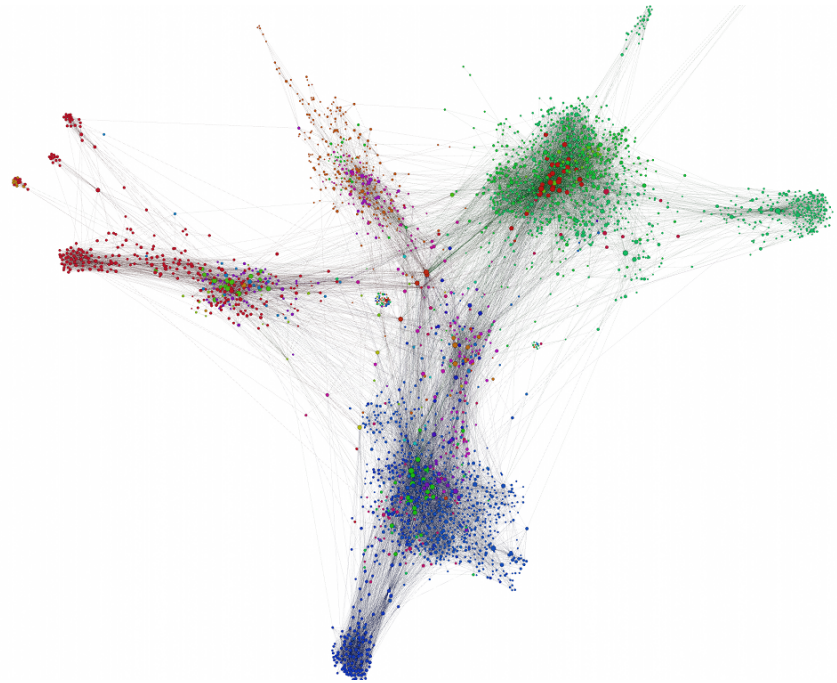
Graphs

Graphs





(Source)



(Source)

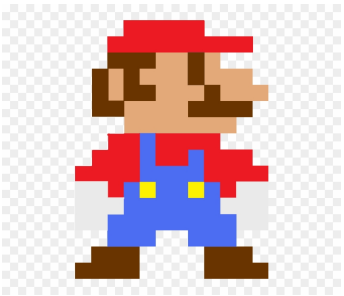
(Video Path-Planning)

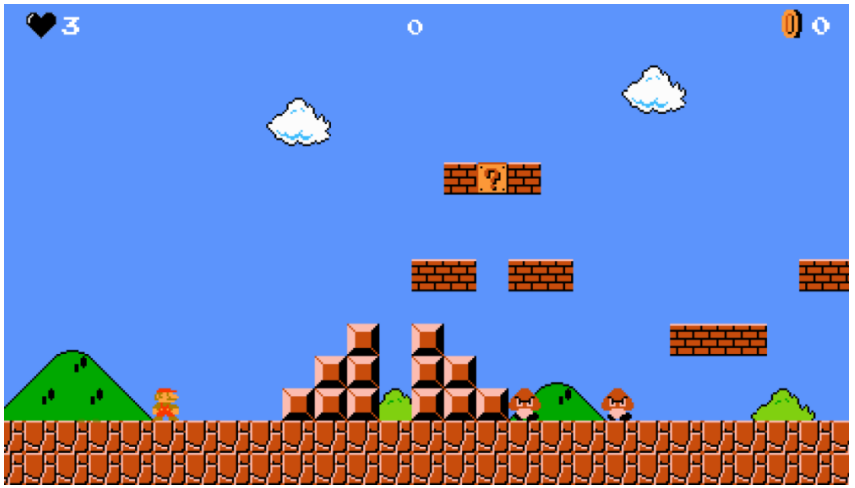
Data structures in Arcade

Sprites (I)

Sprite

A sprite is a 2D image used in videogames



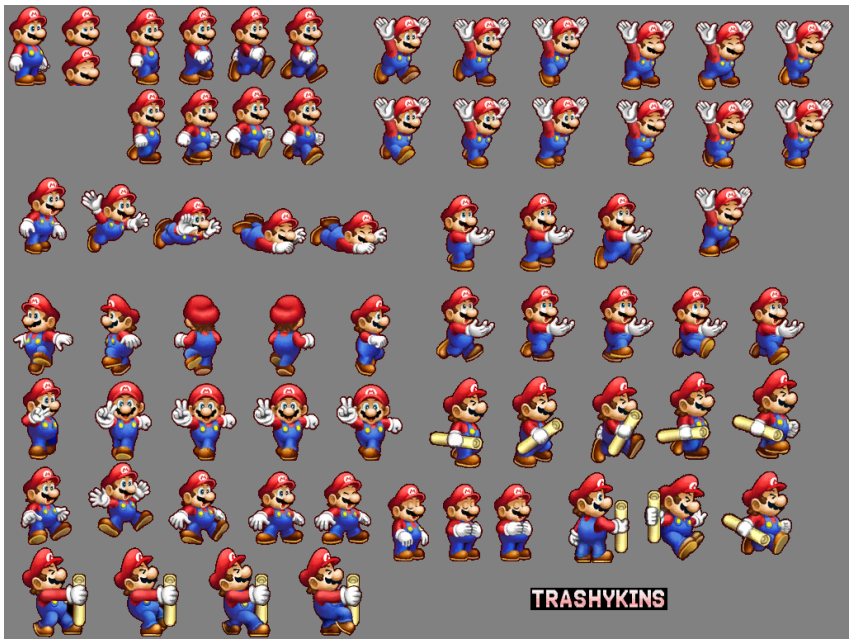


Data structures in Arcade

Sprites (II)

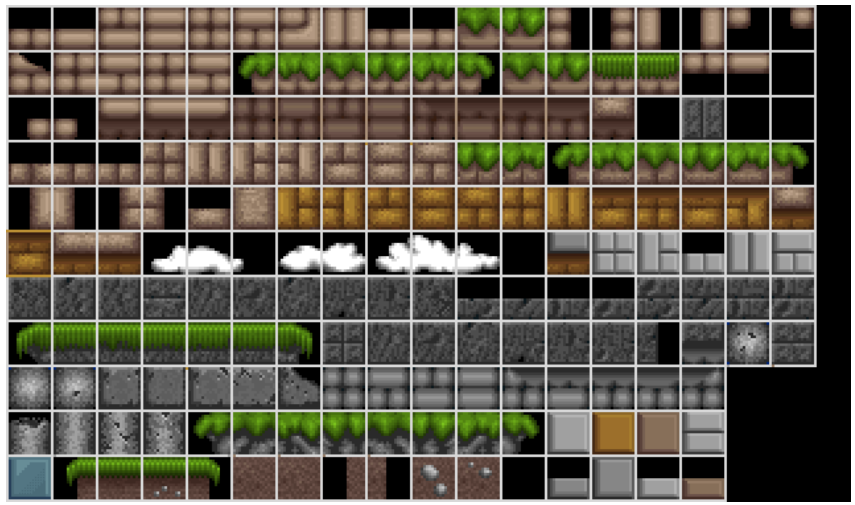
A videogame contains many sprites

- Difficult maintenance
- Solution: Spritesheets



Advantages

- One file contains many sprites
- Less I/O operations $\Rightarrow$ Better performance
- Less memory consumption



Data structures in Arcade

Sprites (III)

In genenal, any data can be stored in three forms

- Not compressed
- Compressed with loss
- Compressed without loss

	Image format	Sound format	Binary data
Not compressed	BMP	WAV	
Compressed with loss	JPG	MP3	
Compressed without loss	PNG, GIF	-	ZIP, bzip, rar, ...

Data structures in Arcade

Sprites (IV)

Attending to what information is stored in image format, there are two types of image formats:

- Bitmap: stores each pixel
  - Scales bad
  - Formats: JPG, PNG, BMP, GIF
- Vectorial: stores coordinates
  - Scales well
  - Not supported by Arcade
  - Formats: SVG, EPS

Many open assets for your games!

- (Kenney)

Data structures in Arcade

Sprites in Arcade (I)

You will need to provide a path to the file

- *Absolute path*: Starts from the root directory
  - Example (Windows): `c:\\Users\atreides\Desktop\mygame\assets\sprites\mario.png`
  - Example (Linux): `/home/atreides/mygame/assets/sprites/mario.png`
- *Relative path*: Relative to the project's directory
  - Example (Windows): `assets\sprites\mario.png`
  - Example (linux): `assets/sprites/mario.png`

Always use relative paths in your projects!!!

Data structures in Arcade

Sprites in Arcade (II)

Sprites are a fundamental concept in Arcade

Creating a sprite

```
character = arcade.Sprite('images/character.png')
```

Placing a sprite

```
character.center_x = 300
character.center_y = 200
```

Data structures in Arcade

Sprites in Arcade (II)

Arcade stores sprites in lists

```
 wall_list = arcade.SpriteList()
wall = arcade.Sprite('images/boxCrate_double.png')
wall.center_x = 300
wall.center_y = 300
```

Lists are manipulated as a whole

```
 wall.draw()
```

And sprites can be removed from the list

```
 wall.remove_from_sprite_lists()
```

Data structures in Arcade

Sprites in Arcade (III)

Arcade stores sprites in lists

```
 wall_list = arcade.SpriteList()
wall = arcade.Sprite('images/boxCrate_double.png')
wall.center_x = 300
wall.center_y = 300
```

Lists are manipulated as a whole

```
 wall.draw()
```

Data structures in Arcade

Sprites in Arcade (IV)

Lists in Arcade implements collision detection and handling

```
hit_list =
arcade.check_for_collision_with_list(player_sprite,
coin_list)
```

And sprites can be removed from the list

```
wall.remove_from_sprite_lists()
```

Data structures in Arcade

Sprites in Arcade (III)

Functional example in (example)

Data structures in Arcade

Sprites in Arcade (IV)

Locating sprites in the game is a tought work

- Closely related to level design
- There are tools that ease this task

(Tiled Map Editor)